OUR NATIONAL LABORATORIES

(COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH)

THE PUBLICATIONS DIVISION

OUR NATIONAL LABORATORIES

(COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH)

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I. INTRODUCTION

It is an undisputed fact that all modern advance is the result of scientific progress. Science has entered into every department of our life, which stands indeed revolutionized by it.

Science plays a very important part in the development of a country's economy and productive capacity. This it does by devising improved techniques, substituting cheap and abundant materials for those in scarce supply and utilizing waste materials.

In view of the vital role of science in national reconstruction and the pressing need for increasing national wealth and raising the living standards of her teeming millions, India, on attaining independence in 1947, decided to press science into the service of the manufacturing industries and, for this purpose, embarked on an extensive and balanced programme of research covering every aspect of the national economy. Since then, a number of laboratories have been set up by the Council of Scientific and Industrial Research all over the country for doing fundamental and applied research in the field of industry. Their number has continued to go up during the years and has now reached twenty-five. With their establishment, the foundation for organized scientific and industrial research in India has been laid. These laboratories have already done research of great value to the country.

Government Policy

The aims of Government policy with regard to science and scientific research were stated in a resolution placed before both Houses of Parliament on March 13, 1958. These are : (*i*) to foster, promote, and sustain by all appropriate means the cultivation of science and scientific research in

all its aspects, pure, applied and educational; (*ii*) to ensure an adequate supply, within the country, of research scientists of the highest quality, and to recognize their work as an important component of the strength of the nation; (*iii*) to encourage and initiate, with all possible speed, programmes for the training of scientific and technical personnel on a scale adequate to fulfil the country's needs in science and education, agriculture and industry, and defence; (*iv*) to ensure that the creative talent of men and women is encouraged and finds full scope in scientific activity; (*v*) to encourage industrial initiative for the acquisition and dissemination of knowledge, and for the discovery of new knowledge in an atmosphere of academic freedom; and (*vi*) in general, to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge.

Position before World War II

Prior to World War II, organized scientific and industrial research under Government auspices had received very little attention. Though the Indian Council of Medical Research and the Indian Council of Agricultural Research had been set up as early as 1912 and 1929, respectively, to promote research in their respective fields, no institute for doing industrial research was sponsored by the State. A few industries had, however, set up their own research organizations. But by and large Indian industry depended on foreign sources and had no research programmes of its own.

Promotion of Research during War-time

During World War II, India became the main supply base for the Allied Forces in the Middle and the Far East. Imports stopped and articles of civilian and military needs had to be manufactured locally. Faced with this situation, the Government of India sought the aid of science to make the most of the available resources. Accordingly, the Board of Scientific and Industrial Research was set up in 1940. Two years later, the Council of Scientific and

Industrial Research was established in April 1942 to promote scientific and industrial research.

After Independence

With the advent of Independence, greater emphasis came to be laid on the provision of additional facilities for the promotion of scientific and industrial research. Recognizing the paramount importance of science for national regeneration and welfare, a separate portfolio for scientific research was created at the Centre on August 15, 1947 under the direct charge of the Prime Minister. The Department of Scientific Research was created in June 1948 and the Board of Engineering Research in 1950 to promote research in various branches of engineering. A separate Ministry of Scientific Research and Cultural Affairs was created in 1958.

Establishment of National Laboratories

A chain of national laboratories (see list in Appendix) have been opened in different parts of the country under the Council of Scientific and Industrial Research. Located near the main industries which they are intended to serve, these laboratories conform to the highest standards and rank among the institutes of their type in the world. Planned by expert committees consisting of scientists and industrialists, they incorporate many of the best features of advanced laboratory design in the world and are furnished with the latest equipment.

Pilot Plants

A feature of the laboratories is the provision for pilot plants where the results of research can be tested for their commercial value. Lately there has been greater emphasis in the national laboratories on pilot plant investigations leading up to actual production.

Fifty-seven such pilot plants are now in operation. The volume of activities of the Council of Scientific and Industrial Research has been growing ever since its establishment. Its recurring expenditure for the year 1960-61 stood at Rs. 4.4 crores as against Rs. 1.08 crores in 1951-52.

II. THE NATIONAL LABORATORIES

1. National Chemical Laboratory, Poona

The National Chemical Laboratory was inaugurated on January 3, 1950 at Poona to conduct chemical research and thus help in the development of India's chemical industry and industrial research. This was the first national laboratory to be established in the country.

Functions and Scope

The Laboratory undertakes fundamental research in general and for the development of industry as a whole. The latter includes survey of raw materials and their industrial potentialities, application of results of fundamental research to industrial problems, utilization of by-products of existing industries, provision of training in specialized fields, provision of aid to industries, and development of key industries. To perform these functions, the Laboratory has been divided into seven Divisions, one each for bio-chemistry, chemical engineering, inorganic chemistry, organic chemistry, physical chemistry, plastics and polymers, and survey and information. The Laboratory also has a library, an auditorium, a museum, workshops, cafeteria, stores and offices.

RESEARCH AND DEVELOPMENT

Investigations on Carbohydrate Materials

The Laboratory has carried out a number of investigations on carbohydrate materials. For instance, a new process has been developed by which an enzyme produced by micro-organisms can be used for the liberation of starch from tubers, thus helping industry to produce starch without elaborate processing equipment. The details of the production of glucose and vitamin C from starch have also been studied and a new enzymic process for the

manufacture of calcium gluconate from starch has been worked out. Cheap sources of proteins have been utilized for the production of valuable ameno-acids. Thus, glutanic acid used in the food industry has been produced from oil cakes.

Utilization of Waste Materials

Processes have been developed for the economic utilization of the country's waste and surplus materials. These include pilot plant production of high-grade gelatin from bones and hides, extraction of nicotine from tobacco waste and the production of several industrial chlorinated products. Processes have also been developed for the utilization of tobacco waste, four to five million pounds of which are annually available in the country, in the preparation of nicotine sulphate solution.

Inorganic Chemistry

In the field of inorganic chemistry, optimum conditions have been established for the preparation, on a pilot plant scale, of titanium tetrachloride by chlorination of ilmenite and rutile, both of which are found in the country. Conditions have been established for the decomposition of unground monazite sand by chlorination. Recovery of rare earths and thorium to the extent of 99 per cent and 88 per cent, respectively, has been achieved.

Organic Chemistry

In the sphere of organic chemistry, work has been done on the utilization of non-edible oils for industrial purposes, thus saving large quantities of edible oils now consumed in soap and other industries. Synthetic aromatics have been prepared under standardized conditions. Weedicides and other agricultural chemicals have also been prepared.

Physical Chemistry

In the Physical Chemistry Division, processes are being developed for producing synthetic gem crystals of ruby, sapphire and rutile used in jewellery and as bearings in

the watch and scientific instruments industries. A simple and inexpensive method of making stable suspensions of technical DDT in water has been developed. A chemical method has been found for the degumming of ramie which is used extensively in the textile and rope industries. Finally, baking enamels and white and brown factice, a processing agent used in rubber industry, have been prepared from tobacco seed oil.

Survey and Information

The Laboratory maintains close liaison between its various Divisions and the industry. Its Survey and Information Division collects scientific and technical information from patent literature and scientific publications, or from experts, and supplies it to industries and research organizations. Information is given to small-scale industries as well. Monographs are prepared on industrial subjects and experiments undertaken to solve *ad hoc* industrial problems. Symposia covering major aspects of applied chemistry are held at the Laboratory periodically.

Collaboration with Research Institutions

The Laboratory supplies chemicals produced by it to universities, and university laboratories are helped to prepare chemicals required for research. A dozen co-operative projects have been undertaken in collaboration with research institutions. The Laboratory has given training in micro-analysis and glass-blowing to individuals sent by research institutes.

2. National Physical Laboratory, Delhi

The National Physical Laboratory was inaugurated at New Delhi on January 21, 1951. It maintains primary and secondary standards, investigates problems relating to the processing and utilization of raw materials for industry, and works out processes developed in the Laboratory on a semi-commercial scale.

Nine Divisions

The Laboratory has nine divisions. These are the divisions of Weights and Measures, Applied Mechanics, Heat and Power, Optics, Electricity, Electronics, Sound, Industrial Physics, and Analytical Chemistry.

ACHIEVEMENTS

Weights and Measures Division

The Weights and Measures Division of the Laboratory has done testing of weights and balances of local manufacture and has rendered technical help to the Standing Metric Committee of the Indian Standards Institution in the implementation of the metric system of weights and measures in India. It has designed and built a number of instruments needed for standardization work. Its other achievements include testing of hypodermic syringes for performance and accuracy and construction of an electric device, called the Metal Detector, for the prevention of smuggling of precious metals.

Applied Mechanics Division

A number of problems, such as those of friction in fluids, vibrations in machines, bridges and structures, welding and fabrication and the behaviour of materials under high pressure and vacuum, have been studied in the Division. A portable vibration generator has been designed for the study of vibration engineering. Processes have been developed for the anodizing and colouring of aluminium to give it a hard and wear-resistant surface. An apparatus for measuring the thickness of electroplated coating has been designed. Accelerated weathering tests on foam concrete panels have also been carried out for the Government Housing Factory.

Heat and Power Division

The possibility of utilizing solar energy for heating, air-conditioning and refrigeration and for the generation of mechanical or electrical energy has been explored. Cooking with solar heat has also been tried. The equipment

consists of a reflector by which heat is concentrated on an insulated, pressure type cooking vessel. Mounted on a frame, the reflector can be rotated to receive radiation from the sun.

Testing Laboratory

A testing laboratory for oil engines and power machinery of medium and small sizes has been set up at the Laboratory to test and certify portable producer gas plants for transport vehicles. Research on alternative motor fuels, such as producer gas, rectified spirit, power alcohol and power alcohol-petrol blends, has also been undertaken. Besides, use of vegetable oils and colloidal fuels as diesel fuels has been tried.

Optics Division

Photographic standardization, research on photographic materials, the development of lenses, cameras and microscopes and the maintenance of absolute standards for illumination are the major activities of the Optics Division. Besides, a photo multiplier unit for the measurement of light intensities has been designed and built. Analysis of several types of materials used in processing and producing industries has been conducted and assistance given to the Geological Survey of India, the Rare Minerals Survey, the Atomic Energy Commission and other organizations. The purity of rare earths produced in the processing of monazite sand is being tested in the X-ray unit.

Metal Evaporation Unit

Worthy of special mention is the metal evaporation unit at the Laboratory for coating surfaces with thin metallic films. Aluminized surfaces have thus been prepared for various types of interferometers. A new method has also been evolved for determining accurately the principal refractive indices of crystals.

Electricity Division

The Electricity Division has assisted the scientific instruments industry in testing and calibrating Wheat-

stone bridges, resistance boxes, post office boxes, meters and other electrical apparatus required for teaching and research, while a number of precision electrical instruments have been installed to test articles like household meters, fans, transformers and lamps. A demountable type of X-ray tube, an X-ray spectrometer and different types of scales have also been constructed.

Electronics Division

The electron microscope in the Division has attracted research workers from all parts of the country. Important problems like the morphology of diatoms, diffraction patterns of minerals and liquid gold deposits on porcelain surfaces have been studied.

Sound Division

Fundamental research on ultrasonics has been in progress in the Division for the past few years. More recently, interesting results were obtained on the relation between sonic and thermal energies. Tests on acoustic properties of foam concrete panels were carried out for the Government Housing Factory. The manufacturers have also sought the help of the Laboratory for the testing of prototypes for loudspeakers assembled in India.

Industrial Physics Division

The importance of carbon products for many industries has led the Division to undertake investigations on the production of various types of carbon compositions. Brushes are now being produced on a pilot plant scale and supplied to Government departments and industrial concerns. The process has been leased out for commercial exploitation. Efforts are also being made to produce arc carbons, big electrodes, carbon oil seal rings and other carbon articles. At the same time, work has been undertaken to use the Indian graphite ores for the manufacture of carbon-graphite brushes, black lead pencils, dry cells, graphite paints and lubricants.

A method has been developed to judge the uniformity of production for pencils as also their writing quality. An

apparatus for the preparation of standard cement samples as well as a bone digester on the Japanese model for use in the villages and a manually-operated bone crusher have also been designed. Lastly, a process for the preparation of activated manganese dioxide from indigenous raw materials has been worked out and a pilot plant set up to study its commercial possibilities.

Analytical Chemistry Division

Analysis and testing of alloys, ores, plastics and structural materials have been done in the Division for the Atomic Energy Commission and other Government and semi-Government organizations and private industry. A special container has been devised for the anti-tuberculosis campaign of the WHO and UNICEF in India.

Radio Components

Processes have been developed for the manufacture of important radio components. The production of silver mica capacitors, high frequency ceramics, electrolytic capacitors, volume controls, etc., has been started on a pilot plant scale. The 'printed circuits' technique for the manufacture of electronic equipment developed during World War II is being applied to the production of radio components from indigenous raw materials. A high temperature sintering furnace and auxiliary equipment have been built in the workshop for the study of high dielectric and high frequency ceramics.

Ink Utilization Project

Research on the production of stamp cancelling ink required by the Department of Posts and Telegraphs, cyclostyle machine ink, newsprint ink and other oil-based inks has also been completed at the Laboratory. Also, various other types of inks are produced and sold.

Collaborative Research

The Laboratory is also collaborating with a number of research institutions and organizations in respect of various

problems. For instance, a scholar from the Saugor University studied the wall structure of diatoms; another from the Delhi University is carrying out research on various types of clay minerals; and a third from the Central Drug Research Institute, Lucknow, is working on electron-microscopic study of the haemaglutination in the case of tropical pulmonary eosinophilia.

Workshop

The Workshop is engaged in making scientific instruments for both the Laboratory and outside agencies. Special efforts are being made to improve metal finishing through anodizing, plating, metallizing and sand blasting.

Documentation Centre

In order to provide documentation services to the national laboratories, scientific institutions, universities and industrial concerns, the Indian National Scientific Documentation Centre has been established at the Laboratory in collaboration with UNESCO.

The Centre has reciprocal arrangements with the Commonwealth Scientific and Industrial Organization of Australia, the National Research Council of Canada and the Institute des Fruits et Agrumes Coloniaux, Paris, for the free supply of microfilm copies of scientific papers published in these countries.

3. Central Fuel Research Institute, Dhanbad

Besides water and power, fuel is the chief source of energy and its development and utilization are essential for economic progress. Coal is an important fuel whose reserves, particularly of coking quality coal, are not adequate for our national requirements and need to be worked efficiently and used economically. Research is needed for both these purposes.

Moreover, fuel, especially coal, yields various by-products valuable in the chemical industry. Fuel research enables us to extract these useful products from coal. Thus the importance of fuel research is quite obvious.

Establishment of the Institute

In view of this, the Central Fuel Research Institute was set up at Jealgora, Dhanbad, in August 1950 to undertake fundamental and applied research in solid, liquid and gaseous fuels. It has specialized research laboratories, including coal and coke testing and carbonization, inorganic and micro-chemical laboratories and miscellaneous research sections.

Coal Research

The Institute specially concentrates on coal research which includes coal survey, coal utilization, standardization, extraction of by-products from coal and fundamental research.

Coal Survey

The Institute is engaged in the task of surveying and assessing the country's coal resources. The basic work includes physical and chemical examination of coal seams as well as chemical uses of coal and correlation of the results with actual usage in order to help industry. The survey also assists in proper industrial planning by determining the available supply of each type of coal during the next 25, 50 or 100 years. Already, several hundred samples from Jharia and Raniganj coalfields have been investigated and a survey of the Bermo seam in the Bokaro coalfields has been carried out to assess its suitability in the thermal power plant of the Damodar Valley Corporation. The coal deposits in the former States of Madhya Pradesh and Vindhya Pradesh have been surveyed and washability tests performed. The washability characteristics of the coal seams of Hyderabad have also been investigated.

Coal Utilization

As a step towards conserving the deposits of coal, the use of pre-heated secondary air has been suggested for non-coking, coal-using loco boilers of railway engines. The cleaning of coal of inferior grade with high ash content has been a major item of research at the Institute which has also obtained, by low temperature carbonization, valuable soft coke that could be utilized as smokeless domestic fuel.

Determination of New 'Toughness Factor'

Further, the mechanism of self-heating of coal has been studied and methods of storage are being followed to reduce the risk of fire. Research on the breakability of coal has led to the determination of a new 'toughness factor'. Samples of lignite from South Arcot have been analyzed and tested and its montan wax content studied for commercial extraction and utilization.

Carbonization

The shortage of metallurgical coal has been a handicap for the iron and steel industry. As a result of research done at the Institute, the life of coking coal reserves is likely to be doubled. An electrically heated carbonization oven has been installed at the Institute. The oven has a by-product recovery train. The testing of the carbonization properties of coal is done along modern lines.

Special Products from Coal

The Institute has prepared a number of important products from coal, some of which used to be imported in large quantities. It proposes to set up a synthetic oil plant. Work has been undertaken on the Fischer-ropsch synthesis and hydrogenation of coal and tar. A pilot plant has been constructed on the fluidized principle and it is capable of producing about a gallon of oil per day. A high pressure coal and tar hydrogenation laboratory has also been set up and certain types of coal and tar have been successfully hydrogenated.

Gasification

Gasification of Indian coal and coke is of great economic importance. This has been done by fluidization and a fluidized technique has been evolved for the rapid carbonization of pulverized non-coking coal at low temperature. This method gives high yield of tar for hydrogenation and also a reactive residue for gasification.

Standardization

For purposes of standardization, the Institute works in collaboration with the Indian Standards Institution. It gives advice on standard specifications for sampling, size-grading, analysis and testing of coal and coke. It has made many new suggestions in sampling and sizing and framed Indian and international standards for the analysis and testing of coal.

Fundamental Research

Fundamental research is also being conducted by the Institute. Already it has carried out investigations in coal cleaning, analytical chemistry, spectrographic methods of analysis, calorimetry, chromatography of coal extracts and coal tar fractions, etc. X-ray investigations on the structure of coal and coke and on the minerals found in coal have also been under study.

4. Central Glass and Ceramic Research Institute, Jadavpur (Calcutta)

Of late, there has been considerable increase in the domestic demand for glassware and ceramic products. Glass and ceramic research was needed to help the industry to meet this increased demand. This resulted in the establishment of the Central Glass and Ceramic Research Institute.

The Institute was set up at Jadavpur, near Calcutta, in August 1950 to conduct glass and ceramic research. Its

other functions are testing and standardization, providing technical assistance to industries, dissemination of technical information and imparting of training. Besides fundamental research, problems having a direct bearing on the glass and silicate industries are studied and examination of special projects and inspection of factories carried out. The latest and most up-to-date equipment has been installed at the Institute. This includes experimental furnaces, pilot plants and apparatus for testing refractories, glassware, enamel goods and pottery articles.

Progress of Research

Work has been done on the availability and beneficiation of sands, sandstones, etc., for glass manufacture. The results have shown that there is an abundance of these raw materials almost in every State. Processes have been worked out for the improvement of the quality of poorer grades, and a number of units like sand-washing plants, magnetic separators, etc., have been installed. Many hundred samples of clay for the ceramic industry have been examined and investigations on the properties of talcs available in the country carried out.

Standardization

Glass articles of superior quality have been manufactured by the Institute in collaboration with the Indian Standards Institution. Specifications for glass ampoules, vaccine phials and glass sands have been drawn up. Standards for limestone and dolomite for glass making and clays for the ceramic industry are being laid down. Other research done by the Institute includes the working out of specifications for glass used in the manufacture of glass containers, use of indigenous raw materials for making saggars, production of enamels from raw materials without using borax, the use of Didwana saltcakes for soda ash, development of insulation bricks from waste mica, use of locally available material for glass bangles, preparation of foam glass and black glass, production of optical glass and the making of artificial teeth.

Technical Assistance

The Institute has rendered technical assistance to industries, Government departments and educational and scientific institutions in various ways.

5. Central Food Technological Research Institute, Mysore

Food shortage became India's major problem after the partition of the country and with the rapid growth of population. This brought home the need for research in food technology in the country. Consequently, the Central Food Technological Research Institute was set up in October 1950 at Mysore to conduct research in food technology.

Scope and Functions

The Institute deals with all aspects of food technology. Its scope of work includes the development of improved methods of storage of staple foods and perishable stuffs like fruit, vegetables, meat, fish and dairy products, reclamation of insect-infested foodstuffs, processing and preservation of food, treatment of coarse food materials to improve their quality and value, production of concentrated foods and vitamins and detection and prevention of adulteration. Fruit processing and preservation and the preparation of squashes, jams, pickles and *chutneys* also form an important part of the Institute's activities.

Storage and Preservation

The Institute has carried out investigations on storage and refrigeration which have shown that the treatment with mercury vapours is effective in keeping foodgrains free from insect infestation. Methods have been developed for the storage of grains. These include the impregnation of jute bags with a weak solution of insecticides and the sprinkling of tomorin along the walls of food stores in order to control damage by rats. Methods have also been

devised for the preservation of roasted and salted cashew kernels at ordinary temperatures for periods of seven months. Optimum conditions of temperature and humidity have been determined for the storage of fruits, vegetables and other perishable commodities.

Processing Techniques

Techniques have been evolved and methods standardized for the processing and canning of fruits and vegetables. Besides other fruit and vegetable preparations, the cashew apple has been used to make jam, candy and pickles, and twelve different products, such as pickles, *chutneys,* preserves and candy, have been prepared from tender bamboo shoots after freeing them from harmful ingredients. Vanilla essence has been prepared from Indian vanilla beams and fruit bars from *amla* which is twenty times richer than the orange in vitamin C. Techniques have also been worked out for the removal of the bitter aftertaste of orange juice and squashes.

New Processed Foods

India has been importing large quantities of foods for infants and invalids from foreign countries at a high cost. Some of these products are now being manufactured by the processes patented by the Institute. To meet the shortage of milk and milk products in the country, a palatable and suitably fortified vegetable milk has been prepared from groundnuts. One pound of groundnut yields about 8 lb. of milk. Its price is about a third of cow or buffalo milk and it is held to be equally nutritious. Curd and buttermilk can also be made from it.

Synthetic Rice

The shortage of cereals constitutes the major food problem in the country. Experiments have shown that up to 25 per cent of rice, wheat or millet can be replaced by tuber products like tapioca without any adverse effect on health. Synthetic rice, for instance, has been prepared from tapioca flour and groundnut cake flour. It tastes

like rice and is cooked in about a third of the time taken for cooking rice. Both tapioca and groundnut are extensively grown and are easily available in India. A method for preparing glucose from tapioca starch has also been evolved. Moreover, *suji* and flour of good quality have been made from tapioca. Also, composite protein food with a casein base fortified with vitamin B and essential minerals has been evolved.

'Mysore Flour'

A cheap and nutritive product called 'Mysore flour' has been made from tapioca and groundnut cake. In some of the gruel centres in Madras and Mysore States, thousands of people were fed daily on this food to prove its value in areas where there was shortage of food.

Infant Foods

Methods have been standardized for the preparation of malted milk powder from ragi malt extract and milk. It has an acceptable taste and a good flavour and compares favourably with well-known imported brands. Two kinds of foods for infants and invalids, with and without cocoa, have been prepared.

Starch from Banana Stem

A method has also been developed for the preparation of edible and industrial starch from banana stem which was being wasted. A stem yields 1½ lb. to 3 lb. of starch and makes good quality custard powder. The mash liquor yields a mineral fertilizer rich in potash and the fibre can be used as fodder.

New Beverages

Recipes have been evolved for cold drinks made from indigenous fruit. The ginger cocktail, a non-alcoholic beverage, for instance, has become popular. A good beverage called the passion fruit squash has been made from passion fruit which grows in plenty in Coorg and the Nilgiris, while an invigorating drink is derived from the cashew apple, 5,500,000 maunds of which are wasted annu-

ally. Tonic wines have been made from Indian fruits and medicinal herbs. Brandy from tamarind pulp, coffee and mint liquor and new beer-like beverages have also been made.

Utilization of Non-edible Waste Material

It has been found that coffee husk, which contains 0.2 to 0.6 per cent caffeine and is a non-edible waste material, can be used to make French coffee. Investigations are under way to devise methods for the detection of adulterants in coffee, for the preparation of a soluble coffee and coffee tablets, for a "wetting technique" to get more cups of good quality coffee from a given amount of powder and for the development of quicker techniques of processing parchment coffee.

Quality Control

Investigations have also been carried out on little known foods in order to utilize them for supplementing the food supply or for industrial purposes. For instance, it has been found that the seeds of *Amaranthus paniculatus* (*Rajgira*) are rich in protein of high biological value and are about three times as nutritious as rice. The puffed grains of this plant can be a cheap and nutritious breakfast food.

Other Researches

Research on *Agava vera-cruz* which grows under semi-arid conditions and is commonly used for fencing showed that the tuberous part of the steam is rich in polyfructosans. The latter has been converted by simple acid hydrolysis to fructose, a very sweet and costly sugar which is of special interest to the confectionery industry. Garlic and onion have also been found to contain polyfructosans and to have a carbohydrate make-up similar to that of *agave*.

Detecting Adulteration of Ghee

A method of detecting adulteration of *ghee* by the use of phenolphthelein has been standardized. Qualitative chromatographic analysis of carbohydrates and amino-acids has also been carried out on a number of articles of

food, including potatoes, carrots, beet roots, knol knol, red marrow, ash gourd, small gourd, cucumber, coconut, betel leaf, lime fruit and guavas. The nuts of *Terminalia bellerica* have been found to be rich in fat and proteins.

Designing of Equipment and Machinery

While methods are being developed for the preservation, processing and utilization of food material, equipment and machinery have also been designed and built for research projects. These include equipment for flash pasteurization of beverages, deodorizer for the removal of nutty flavour in vegetable milk, pilot plants for the extraction of alcohol from oil-seeds and the preparation of synthetic grains, vegetable milk, banana starch and malt; rasper for the manufacture of starch from tapioca; the forced circulation vacuum evaporator and a jet condenser for vacuum concentration of thin liquors, milk and juices; and a new type of film evaporator for the concentration of highly viscous liquids, besides special types of evaporators, stills and vacuum dryers.

Technical Aid Programme

The Institute has a technical aid programme which includes advice and supply of information to food processing industries and interested persons. Bibliographical surveys of literature on food technology, statistical studies of raw materials for food industries and their finished products, and nutritional and diet surveys on special projects have also been carried out. Articles and abstracts from journals have been translated, while a quarterly bulletin on the progress of food technology is being brought out, in addition to a monthly journal. Further, about 40 leaflets and one brochure have been published to encourage food industries on a small scale.

6. National Metallurgical Laboratory, Jamshedpur

The National Metallurgical Laboratory was established at Jamshedpur in 1950 to carry on metallurgical research and thus assist the growth of metallurgical industries in India.

Six Divisions

The Laboratory has six Divisions, one each for general metallurgy, physical metallurgy, chemical metallurgy, refractories, ore-dressing and mineral beneficiation, and technical metallurgy and testing.

Functions

The main functions of the Laboratory are application of the results of research to commercial conditions, testing and standardization of manufactured products, collection of data and technical information and provision of facilities for the solution of industrial problems.

Beneficiation of Ores

It is estimated that for every ton of mined high-grade manganese ore nearly three to four tons of low-grade ore is left unrecovered. This is a considerable loss particularly as the deposits of manganese in the country are by no means unlimited. Beneficiation experiments by thermal treatment of low-grade manganese ore (36%) have been carried out and a 50 per cent concentrate has been recovered.

Development of Ore-dressing Techniques

Metallic ores, as found in nature, are not always suitable for direct processing unless improvement is brought about in the grade by ore-dressing processes. Ore-dressing techniques are, therefore, being developed for different ores. Low-grade chromite ores from Talur, Arsekere, Dodkatur and Dodkanya (Mysore) and Kittaburu (Bihar) have already been examined.

Utilization of Low-grade Ores

Sulphur is an important industrial raw material. To make up for its shortage in the country, experiments are being made to utilize low-grade pyrites from Wynaad (Nilgiris), and Karwar and Chitaldrug (Mysore) by concentration. Preliminary investigations have shown that the latter may yield about 15,000 tons of sulphur after suitable beneficiation. The low-grade wolfram ore

from Rajasthan has been upgraded and a marketable concentrate produced. Of topical interest in the atomic age is the method employed for the concentration of low-grade uranium ores.

Metal Extraction and Refining

Experiments have been carried out on the production of nodular cast iron, using an alloy of 75 per cent copper and 25 per cent magnesium. Nodular cast iron can be used to replace steel castings; and this is important as there is a shortage of steel in the country. The mechanism of graphite formation in nodular cast iron has also been studied in order to apply the process to Indian pig iron.

Chemical and Electrolytic Manufacturing Processes

The possibilities of the manufacture of electrolytic manganese, beryllia and titanium have been examined. Already, manganese has been produced on a pilot plant scale. The method of making beryllia by chemical, electrolytic and chlorination processes is being investigated. A pilot plant scheme has been drawn up for the chemical production of 2,400 lb. of beryllia annually, and it has been accepted by the Central Government.

Application of Electrolytic Method to other Ores

Ilmenite is one of the ores largely available in the country, and it is the principal ore for titanium. Metallic titanium has been prepared from ilmenite. An electrolytic method of extracting the metal is also being developed. At the same time, the production of high purity manganese dioxide for dry battery cells is being investigated. An electrolytic method has been developed. Experiments are afoot to discover an inexpensive process for the production of aluminium and silicon alloys which are widely used in the engineering and automobile industries, but which are at present expensive to produce.

Aid to Industry and Government Departments

At the instance of Messrs Tata Iron and Steel Co. Ltd., research was undertaken on the manufacture of low

carbon ferro-chrome by reducing chromite with ferro-silicon. The results have been satisfactory. Also, the Mint at Bombay referred to the Institute the problem of recovering nickel from silver-refinery waste liquors. A method of separating zinc as sulphide and nickel electrolytically has been worked out.

Substitution of Scarce Metals

The possibility of replacing plated steel and other materials by aluminized steels to conserve nickel, chromium and tin has been examined. The process of dip-coating and heating mild steel with a packing of aluminium, alumina and ammonium chloride has been studied in this connection.

The response of alloy steels to the addition of aluminium and heat-treatment is under study. The amount of aluminium to be added to produce maximum inhibition to growth in plain carbon as well as in nickel chrome steel has been ascertained. The control of grain size by such addition improves the mechanical properties of steel. The Laboratory has developed processes for the production of nickel-free stainless steel. A pilot low-shaft furnace is under erection for investigations on the production of iron with the use of non-coking and inferior coals.

Development of New Permanent Magnet Alloys

The established alloys for permanent magnets contain nickel and cobalt which are not found in the country. An attempt is, therefore, being made to develop permanent magnet alloys of iron, manganese and aluminium. The alloys of Fe-Mn-Al prepared both by the powder method and by melting, casting and annealing have been shown to retain magnetism. Incidentally, it has been found that some Fe-Mn-Al alloys show resistance to corrosion and to high temperature oxidation.

Evolution of Processing Methods for Refractories

India has one of the largest deposits of sillimanite in the world, but they have not so far been properly utilized.

It is obtained as a by-product in the process of extracting monazite and ilmenite from the sands on the beaches in Kerala. Suitable sillimanite refractory compositions and methods of processing are being evolved by preliminary investigations and tests of these products. Work on the manufacture of graphite, silicon carbide and super-basic refractories is in progress. It is anticipated that these will compare favourably with standard imported goods.

Petrographic studies are also being made on raw materials for refractories.

Plating Industry

Among investigations undertaken on electroplating, the substitution of cyanide by non-cyanide baths for the electroplating of brass, the technique of plating metals on non-metals like glass, wood, paper and porcelain and chromium plating on aluminium constitute some of the important achievements.

Mechanical Metallurgy and Testing

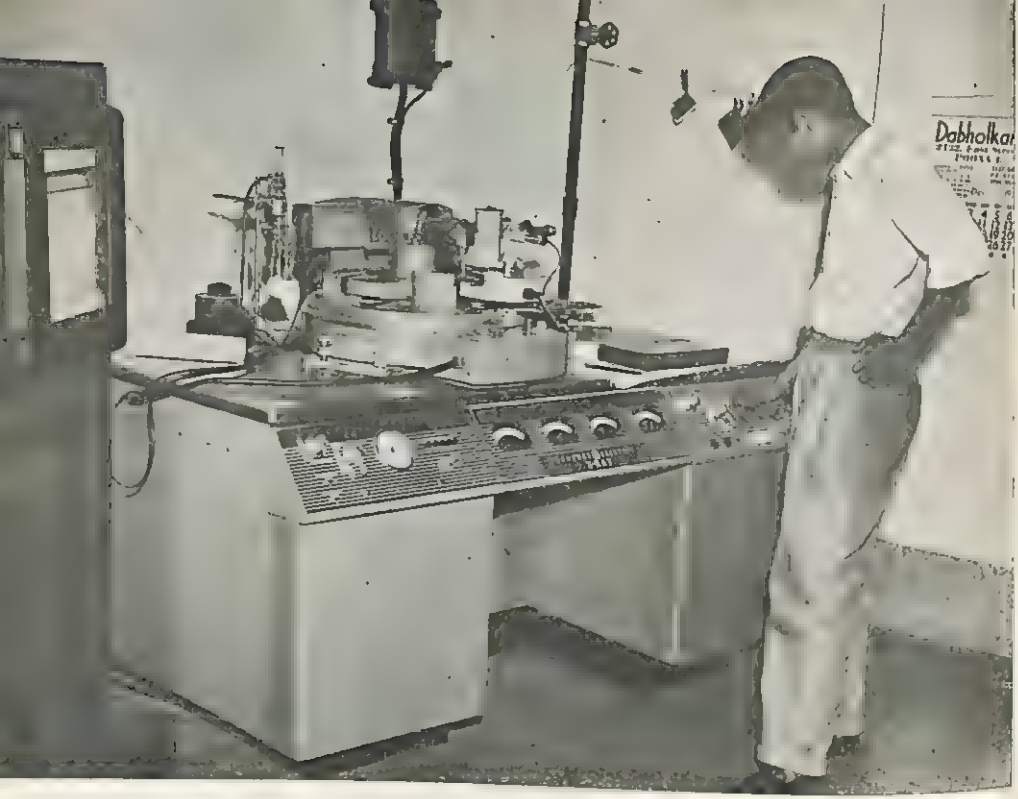
The users of metal products are naturally interested in testing specific performances of the products they buy. In this connection, considerable work has been done on the wear of railway wheels, tyres and axles, and the factors accelerating wear have been determined. Work is being continued to correlate wear resistance with the physical properties and structure of materials.

Aid to Industry

Two types of problems have been referred to the Institute by industrial and Government organizations. One involves investigation of an industrial process or scheme of development, and the other relates to the examination of operational difficulties or service failures. As an example of the first type, mention may be made of the work done for the aluminium industry on the disintegration of Soderberg electrodes and on the separation of cryolite from carbon dust produced in the reduction furnaces.

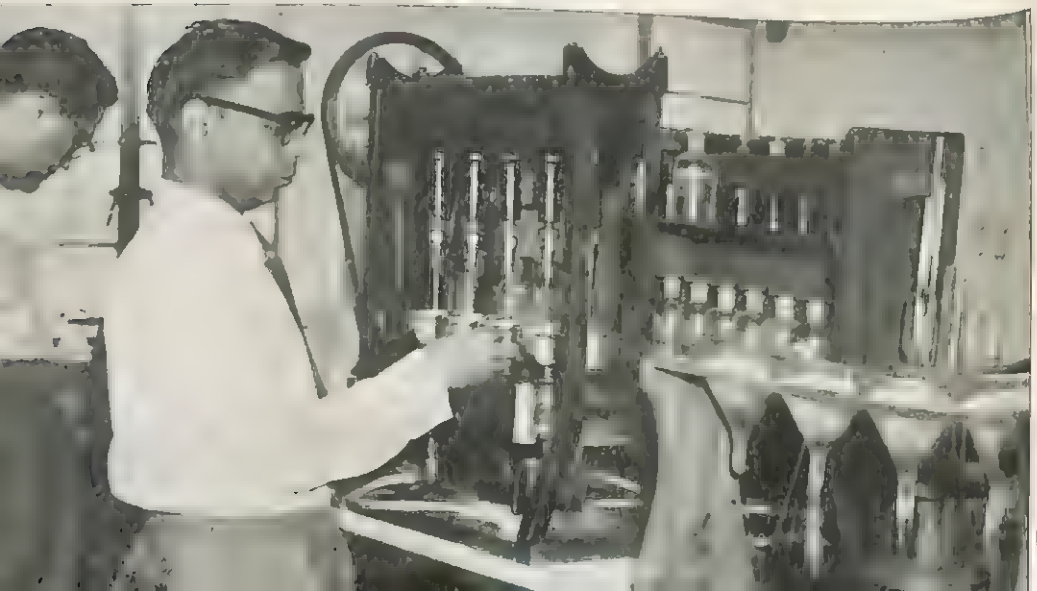
Central Salt Research Institute, Bhavnagar

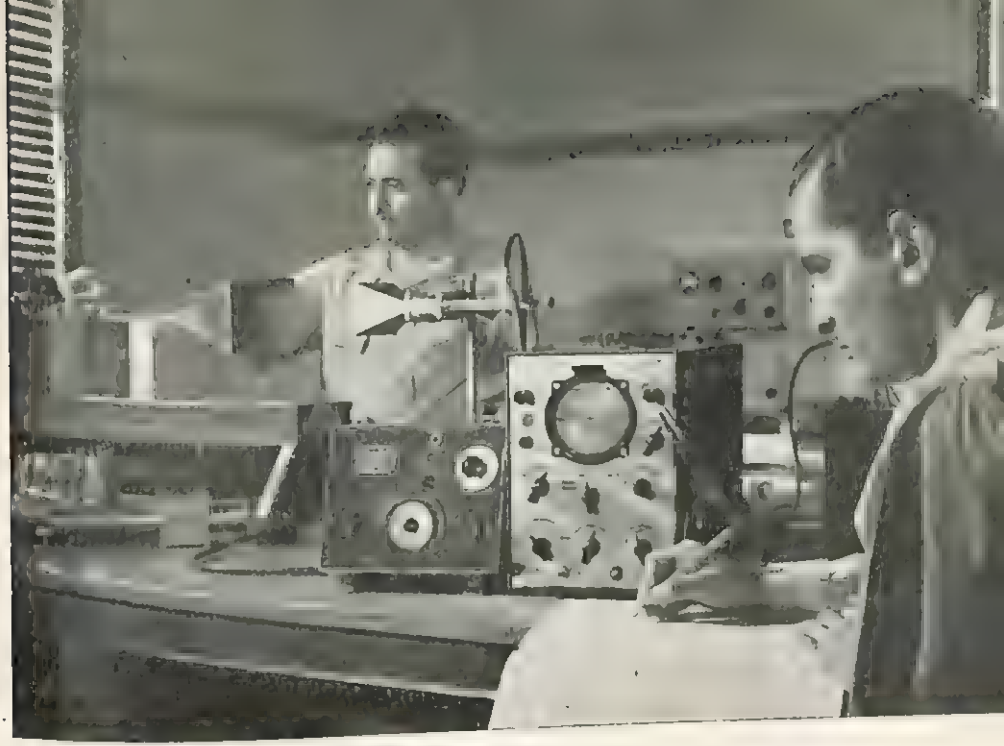
The library at the National Chemical Laboratory, Poona



An X-ray diffraction spectrometer at the National Chemical Laboratory, Poona, which is used for studying the crystal structure of organic or inorganic compounds and minerals

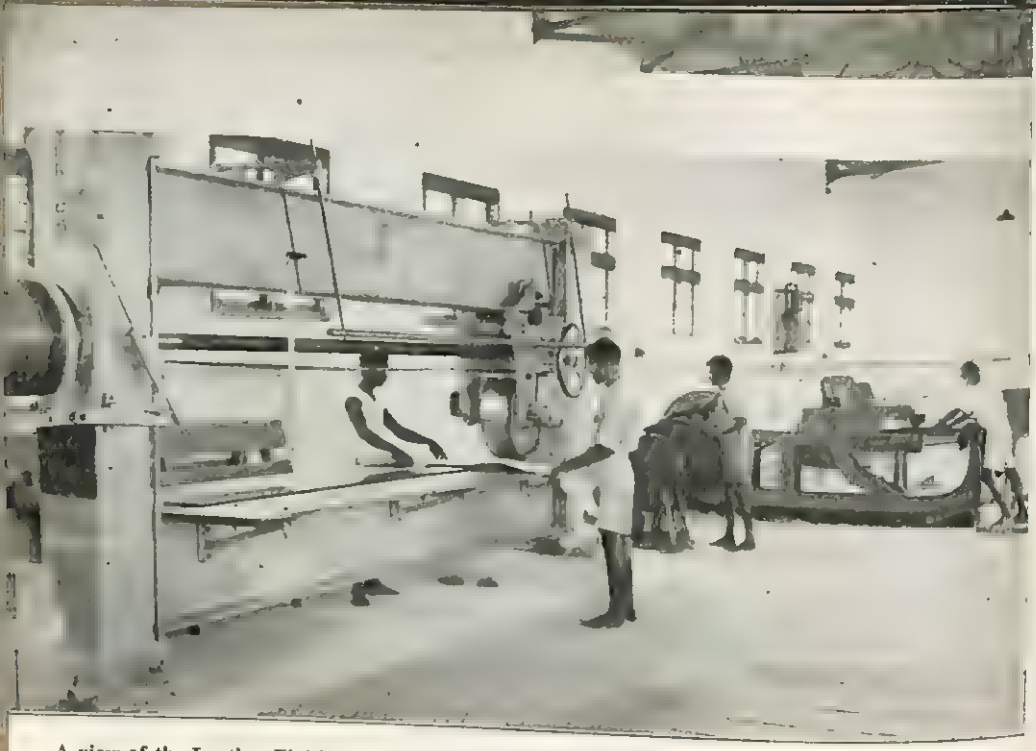
Inside the Heavy Chemicals Section of the Regional Research Laboratory, Hyderabad





An experiment in progress at the National Physical Laboratory, New Delhi

Optical glass testing in progress at the Central Glass and Ceramic Research Institute, Calcutta

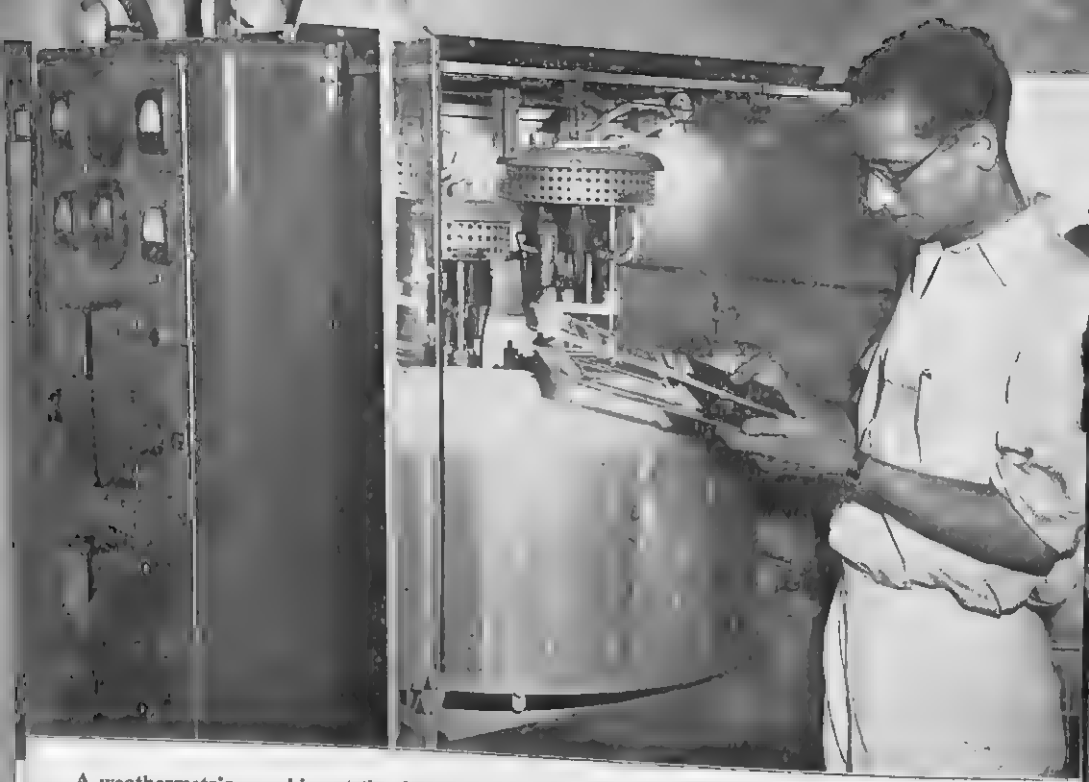


A view of the Leather Finishing Yard at the Central Leather Research Institute, Madras

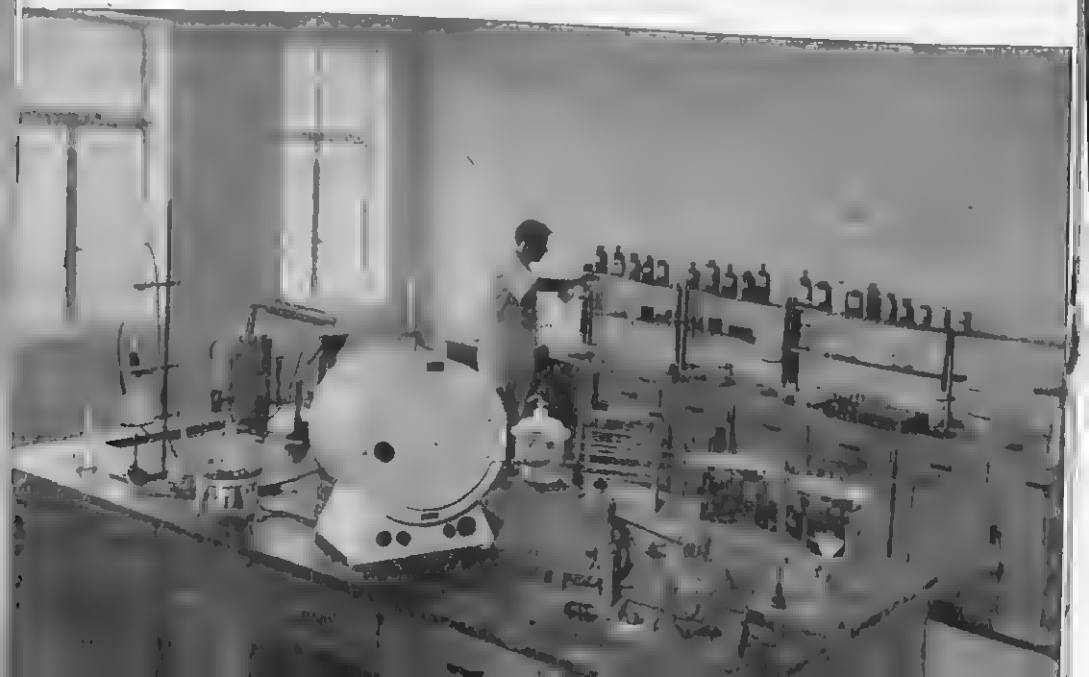
Articles made of nickel-free stainless steel developed at the National Metallurgical Laboratory, Jamshedpur

A model of a traffic island designed by the Central Road Research Institute, New Delhi

Multi-purpose food produced at the Central Food Technological Research Institute, Mysore

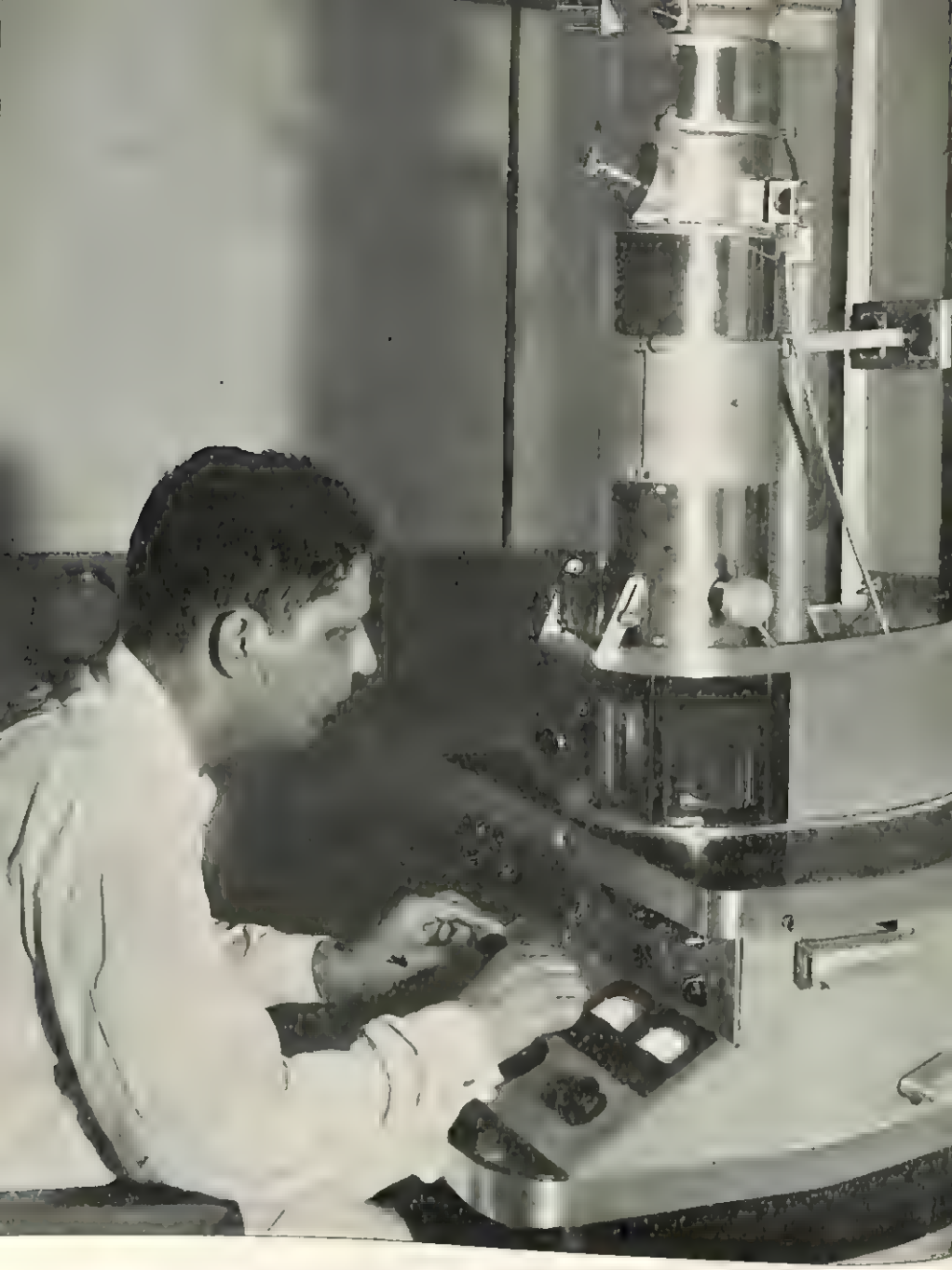


A weathermetric machine at the Central Building Research Institute, Roorkee, which adjudges the effects of weather on paints used in the building industry



At the Central Food Technological Research Institute, Mysore

Left : The electro-metallurgical laboratory at the Central Electro-Chemical Research Institute, Karaikudi



An operator at work on an electronic microscope at the National Physical Laboratory, New Delhi

A solution has been found for problems of plating experienced by the *jari* plating industry in Surat owing to bad colour, burnt deposits or non-deposition. The successful recovery of nickel and zinc from waste liquors after silver and copper have been recovered from old silver coins is an instance of research done for the Mint in Bombay.

Technical assistance has also been given to a large number of industries, including iron and steel works, mining and metallurgical industries, rolling mills, foundries, engineering works, non-ferrous metallurgical works, collieries, etc.

7. Central Drug Research Institute, Lucknow

The Central Drug Research Institute was set up at Lucknow to meet the need for collaborative effort at drug research in the country.

Scope and Functions

The research activities at the Institute embrace a wide field extending from a systematic study of drugs that have been in use in indigenous systems of medicine for centuries to the highly developed field of synthetics and antibiotics.

Nearly 35 per cent of the drugs listed in the British Pharmacopoeia are native to India and substitutes for a large number of others can probably be found. Much of the country's indigenous drug resources are still unexplored and the Institute organizes systematic work in this field. Also, the techniques of investigation developed in the West for synthetic drugs are being examined with a view to adopting them for the study of such Indian drugs as may be useful in the treatment of the most common diseases in the country.

Collaborative Research

Since most of the activities require team work, the co-operation of specialists in widely diversified fields has

been enlisted. Thus, the different stages in the production of a drug are being studied by experts in their respective fields. The chemist prepares products which are submitted to biological tests by biochemists, pharmacologists, bacteriologists and pathologists. Finally, selected products are tried out first on animals and then on human beings. Substances may thus be found which have either entirely new reactions on the human body or are more effective than remedies already available.

The ultimate object of the Institute is, however, to stimulate progress in the control and treatment of disease through the study of diagnostic, preventive and therapeutic agents. Efforts are also being directed towards the lowering of the cost of medicinal products.

ACHIEVEMENTS

Attempts have been made at the Institute to manufacture standard drugs from indigenous herbs in order to reduce the import of antibiotics, anti-malarials and sulpha drugs involving a heavy drag on the country's foreign exchange resources. An effective substitute for d-tubocurarine has already been found in *Cissampelos pareira* Linn (Zakhmi-hayat). A series of onium, piperiolinium and quinolinum compounds have been synthesized as potential neuro-muscular blocking agents. Preliminary pharmacological experiments have shown activity in a number of these compounds. Good progress has been made in regard to investigations pertaining to important biological preparations like lecithins, nucleic acids from plants, peptones from oil cakes and enzymes from bacteria. A high percentage of lecithins has been obtained from the *urd* and *mung* pulses. A large number of molds and actinomyces have also been isolated. A bacterial strain isolated from a sample of soil from Lucknow has yielded an antibiotic which seems particularly active against the dysentery bacillus.

Histopathological and biochemical work has been done on leucoderma. The nature of anaemia produced by lead acetate in rats is being studied to measure the potency of

anti-anaemic drugs prepared at the Institute and to discover a still better treatment than the one in vogue. New approaches to the treatment of diabetes and high blood pressure are also being made and preliminary results appear promising.

Other Activities

Besides developing new ideas on research, the Institute has become a centre for the training of scientific personnel. As a clearing house for information on drugs, it already ranks as a primary centre for reference and the dissemination of scientific knowledge.

Remodelling of Pharmaceutical Codex

To encourage the use of standard indigenous drugs by physicians and pharmacists, the Indian Pharmaceutical Codex has been compiled on the model of the British Pharmaceutical Codex. Considerable progress has also been made in the compilation of the Handbook of Indigenous Drugs of India, which will be a valuable reference manual for chemists, pharmacologists and clinicians. A good herbarium consisting of 700 sheets of medicinal plants has been opened.

Publicity

The Institute makes attempts to popularize work carried out on drug research by organizing symposia, discussions, extension lectures and radio talks. In this way active public interest is being created in a field of knowledge hitherto inadequately understood in this country.

8. Central Road Research Institute, Delhi

Roads are the arteries of a nation and the importance of good roads for civilian traffic and for the growth of trade and commerce is obvious. The methods of road construction and maintenance in India were, till recently, stereotyped and adequate facilities for road research practically non-existent. Realizing the need for road research, the Council of Scientific and Industrial Research set up the Central Road Research Institute in Delhi in July 1952.

Scope and Functions

The main function of the Institute is to find solutions for the varied problems of road construction, maintenance and improvement. Emphasis is laid on low cost, all-weather rural roads and their construction from locally available material. Test tracks are proposed to be laid in different parts of the country and the results checked under service conditions in different localities.

Progress of Work

Technical work at the Institute started even prior to its formal opening. The study of the compaction of soil for comparison with the one prepared in England had already been undertaken. The identification of Indian black cotton soil, the stabilization of the soil in Kashmir and specifications for surface dressings and for materials not generally used for road construction are some of the investigations which are in progress.

Test Track

A track of about five furlongs on the Bombay-Delhi national highway has been used as a test track for study. The tests, at present, consist of nine different surface specifications with tar and bitumen. Parallel to the test track, a permanent diversion was constructed and traffic diverted over it while work was in progress.

In order to investigate into the durability and economics of the various types of bullock-cart wheel-axle system, a machine called the "wheel-tester" has been built to improve the efficiency of bullock-cart traction which is still an important means of communication in our country.

The construction of multi-storeyed buildings is now considered a necessity, especially in the cities where the land available is limited. The Institute gave technical advice in several cases for determining the actual load-bearing capacity of the ground. Such investigations were completed for the new buildings of the Reserve Bank and the Supreme Court at Delhi and for various buildings at Chandigarh.

Future Plans

As the object of research is to add to the basic knowledge of the engineer, almost all aspects of highway engineering and traffic surveys, including the compilation of road statistics, are dealt with at the Institute. It is necessary not only to construct more roads but also to build them according to requirements. The effects of various kinds of traffic and means of transport have to be studied on different kinds of roads. Suitable notice boards, light signals, road round-abouts and traffic crossings are some of the subjects which have to be dealt with by the road engineer.

Close co-operation has also been established between the Institute and the Roads Wing of the Union Ministry of Transport and other research stations, on the one hand, and similar institutions in the UK, the USA, Australia and other foreign countries on the other.

The work of the Institute has thus become very important. There is need for better roads in the country which play an important part in the overall life of the nation. Without proper roads, agriculture, industry and commerce cannot flourish. The building of more roads is the key to the country's economic and industrial progress.

9. Central Electro-Chemical Research Institute, Karaikudi

Electro-chemical research is of crucial importance for India in her programmes of industrialization. Facilities for such research were, however, non-existent in the country before Independence. Recognizing this need the Council of Scientific and Industrial Research set up the Central Electro-Chemical Research Institute at Karaikudi near Madras in 1953 to conduct research in this field.

Scope and Functions

The Institute carries out exploratory, applied and fundamental research in electro-chemistry. Fuel technology, glass and ceramics, metallurgy, physical chemistry,

organic chemistry and electrical and chemical engineering are closely linked with electro-chemistry and this fact has been kept in view in establishing the Institute.

ACHIEVEMENTS

Electrolytic Manganese

The richer grade of manganese ore is mostly exported. Investigations have been made at the Institute to exploit low-grade manganese ore for the production of pure manganese. A pilot plant unit for the production of 10 lb. of manganese per day has been fabricated and set up. Manganese of high purity has already been produced. Experiments have been carried out to standardize the process and achieve greater economy.

Pure Potassium Chlorate

Pure potassium chlorate is used in the manufacture of munitions. A sample of potassium chlorate was made at the Institute and was found to be 99.9 per cent pure. Common sea salt was used as the starting material.

Cuprous Oxide

Cuprous oxide is used as an anti-fungus and anti-pest chemical and for painting the bottoms of sea-going vessels as a protection against corrosion. The process of its production, however, remains cumbersome and the cost is heavy. Attempts are now being made to produce a standard material at reduced cost. The results achieved so far have been satisfactory and the cuprous oxide thus produced has been found to be as good as the imported material.

Calcium Gluconate

Calcium Gluconate is a well-known tonic for the treatment of calcium deficiency. A few pounds were prepared on a laboratory scale with glucose as raw material, and further work is under way whereby cheaper chemicals will be substituted for more costly ones.

Aluminium

A large quantity of shavings and cuttings is left over in the manufacture of aluminium utensils. An electro-thermal method of getting aluminium (99.6% pure) from scrap has been worked out.

P-Aminophenol

P-Aminophenol is an important dye intermediary. A cell for the production of P-Aminophenol from nitro-benzene on a pilot plant scale has been set up and worked.

Other items of research include the setting up of a smothered arc furnace for the manufacture of calcium carbide; electro-polishing of hard chromium-plating of bearing surfaces; the determination of optimum conditions for refining aluminium in the molten stage; the anodizing and dyeing of aluminium in attractive colours; the recla-mation of pure metals—copper, lead, tin, zinc, etc., from scrap, such as discarded and damaged storage batteries, worn out cables and utensils, tin-cans, etc.; and the prepa-ration of high test hydrogen peroxide, heavy water, caustic soda, sulphuric acid, water-activated reserve type of pri-mary wet cell, activated manganese dioxide, carbon and graphite electrodes, etc.

10. Central Leather Research Institute, Madras

India is the largest single producer of hides and skins in the world. The annual production is estimated at 14.12 million pieces of cow hide, 5 million pieces of buffalo hide, 21.3 million pieces of goat skin and 15.6 million pieces of sheep skin, and their value amounts to about Rs. 40 crores. If all the hides and skins were to be tanned and finished in India, an eventual annual production of about Rs. 80 crore worth of leather may be expected.

The Indian leather industry also ranks fourth in im-portance as an earner of foreign exchange. The total value of leather and leather goods exported is estimated at Rs. 30 to 35 crores annually.

In comparison with the leather industries of the West, India, however, lags behind both in the volume of production and in the quality and variety of finished leather. The bulk of her production is still carried on as a cottage industry and the methods employed are empirical. What is required is the adoption of improved processes and techniques. It is to meet this need that the Central Leather Research Institute, the tenth in the chain of national laboratories, was set up in Madras in 1953.

Scope and Functions

Work at the Institute is devoted to the improvement and modernization of the leather industry in the country. This is sought to be achieved through fundamental and applied research and the training of technologists.

ACHIEVEMENTS

Most of the techniques in use in the Indian leather industry are old. Hence efforts have been made to modernize them through the application of scientific knowledge. Three processes have been worked out for the rapid tannage of sole leather which reduce the time taken in tanning from 3-4 months to 3-6 weeks. An interesting feature is that some of the processes can well be adopted even by the village tanner who has no modern equipment. The leather produced has been found to be very satisfactory and in great demand.

Adaptation of Foreign Processes

Experiments are also being carried out to adapt foreign processes to improve the quality of the indigenous raw material. Already, seven processes have been adapted and found to be satisfactory for producing good leather. Moreover, in order to manufacture glace kid in India and export tanned and finished leather in place of raw skins, ten processes for the manufacture of good quality glace kid have also been worked out.

Evolution of New Processes

At present, roller skins used in spinning mills, picking bands used in jute and cotton textile mills and leather beltings used in factories and workshops are mostly imported. Seven processes for making picking bands and two processes for making roller skins have been worked out. Also, processes are being evolved for obtaining a thickness of 2-2.5 mm. for army boots and shoes by chrome tanning.

A great variety of leather auxiliaries, such as commercial fat liquors, enzyme bates, leather finishes, etc., are imported. Research has been undertaken to develop their manufacture in the country.

The unsatisfactory condition of the Indian tanning industry is shown by the fact that it depends on imported materials like wattle bark and mimosa extract. Experiments are being conducted to find substitutes from indigenous vegetable tan-stuffs. To supplement the fast diminishing natural vegetable tanning materials, processes have been worked out to manufacture synthetic tanning materials from natural phenolic bodies and coal-tar distillation products.

Divi-divi is an indigenous vegetable tan-stuff and is rich in tannin. In spite of its plentiful supply, it is not widely used as it ferments readily and gives a dark colour to the leather. A process has now been worked out by which fermentation is kept in check for a long period and the colour of the tanned leather is also improved.

An important problem for investigation at the Institute is the quality of leather from 'fallen' animals. It is well known that leather from animals dying a natural death is inferior in quality to that obtained from slaughtered animals. The basic causes of deterioration have been investigated and methods evolved to minimize their adverse effects.

Finally, a number of processes have been evolved for the preparation of basic salts for use as tanning agents, and for the production of industrial leathers like suede, upholstery, football covers, etc. Standard specifications

have also been prepared for East Indian tanned kid, goat and sheep skins.

11. Central Building Research Institute, Roorkee

Building research has assumed considerable importance in recent years. The shift of population owing to changing economic and political conditions, the limited availability of land, the shortage of conventional building materials and similar other factors have emphasized the need for research in building techniques and materials so as to reduce costs and improve quality. Specialized institutes for building research have thus been established in all major countries.

Accordingly, a Buildings Research Unit was set up at Roorkee in 1941 to work in co-operation with the Thompson College of Engineering, now the Technical University of Roorkee. Later the unit was transformed into the Central Building Research Institute, which was opened in 1953.

Scope and Functions

Although the problems for investigation at the Institute are by and large the same as in other countries, some are of special interest to India. Particular attention is, therefore, paid to those aspects of materials, techniques and performance in which buildings in this country differ from those in temperate climates, that is, the development of new building materials and novel processes of production, such as better use of soil by stabilization, the use of boiler ash as puzzolana to save cement, lime sludge from sugar factories as a stabilizer, filter press mud for the production of mineral wool, the use of bamboo as a building material and the construction of cheap, durable and sanitary houses for low-income groups, villagers and industrial workers.

Among other aspects which require investigation are problems of design, functional requirements of buildings, basic studies of structures, the standardization of building components and the evaluation of new materials

or substitutes. Attention has also to be devoted to the nature, properties and treatment of clays, minerals and soils. Materials and practices evolved in foreign countries, too, are required to be studied before they are adapted to suit Indian conditions.

RESEARCH WORK

Soil Stabilization

The method of stabilizing soil with cement is well known. There is also the possibility of utilizing some of the industrial waste products for this purpose. Work done at the Institute has shown that lime sludge, a waste product from sugar factories and tanneries, mixed with sodium silicate, can be used for the stabilization of soil. This process can be applied for the base-course of roads for light traffic or for making blocks for buildings.

Bricks

Research on bricks and brick clays has shown that shrinkage can be controlled to a considerable extent by suitably modifying the mechanical composition of raw materials like sand, silt and clay. It is also possible to get bricks of such high crushing strength as 7,000 lb. per square inch as against ordinary bricks with a strength ranging from 1,500 to 2,000 lb. per square inch. This opens up the possibility of manufacturing special types of strong bricks suitable for heavy structures at little extra cost.

Fuel Economy

Preliminary trials have shown that the crushing strength of the bricks made of black cotton clay from the Bombay-Deccan area does not change much over a wide range of firing temperatures. It appears that the firing of such bricks can be done at lower temperature with fuel of less caloric value or with a lesser quantity of fuel than at present.

Study of Fluxes in Brick Earths

Fluxes present in brick earths have also been studied. This may help in finding methods by which the warping of

bricks made out of black cotton soil may be checked during firing. After laboratory experiments, Sindri ash was used in small proportions as admixture to the raw materials for bricks. These have been fired in local kilns under ordinary factory conditions. Experiments are being carried out on the weathering quality and the physico-chemical properties of building stones.

Puzzolans

Preliminary trials with boiler ash from Sindri have shown that it is possible to utilize this waste product to make puzzolanic cement. By this process cement may be conserved by substituting ash up to 25 per cent.

Vermiculite

Exfoliation studies in Indian vermiculite from Mysore were undertaken. The effect of temperature, time and size and the method of measurement of exfoliation have been determined. Cold exfoliation with oxidizing agents like hydrogen peroxide, ammonium persulphate, etc., have also been tried and further investigations are in progress.

LOW-COST HOUSING

Prototypes

A number of panels constructed of cement-stabilized soil blocks and ordinary sun-dried bricks with different plasters and renderings have been built and subjected to weathering for the past two seasons. The stabilized blocks are, on the whole, behaving well. *Surkhi* lime plaster on panels with sun-dried bricks has been found satisfactory, in addition to cement wash.

Thermal Behaviour of Buildings

Preliminary work has been carried out on the thermal behaviour of some of the residential quarters for the staff. The results show the importance of proper orientation of buildings for the achievement of maximum thermal comfort.

Solar Charts

Solar charts for architects and designers have been prepared for some typical regions, namely, Bombay, Hyderabad, Lucknow, Madras, Delhi and Calcutta.

PRACTICAL PROJECTS

CBRI Shell Houses

A few prototype structures have been set up at the Institute to illustrate the application of corrugated concrete shells. The method of construction is shown stage by stage in one of these, while in another the finished house is shown with partitions, doors, windows, lining and painting. The house is 20 feet wide and 23 feet 6 inches long, and it has a floor area of 470 square feet. The total quantity of material required to construct such a house is 2.8 tons of cement, 13 cubic yards of aggregate and 140 square yards of jute hessian. The cost for the structural portion, when produced in bulk, worked out to Rs. 1.75 per square foot of covered floor area. This type of shell house is suited to an equable climate such as in areas near Bombay and Calcutta. For hot arid tracts like Delhi and certain parts of Uttar Pradesh, a double shell roof is necessary, but the cost of construction increases from Rs. 1.75 to Rs. 2.50 per square foot of covered floor area.

Light Duty Floors

A non-conventional technique has been used to build a light duty floor in the above shell house. It consists of an inch thick layer of concrete placed on stretched jute hessian over concrete plunger piles. The loose earth which supports the jute hessian during the construction of the floor settles after a few weeks and an insulating air gap is formed. Thus the floor is cool in summer and warm in winter. Live and dead loads of the floor are entirely carried by the piles. The cost of such floors is estimated at Rs. 34 per 100 square feet.

Twin-twisted Steel Bars

In Europe and America, a process is used for improving the strength and other qualities of reinforced steel by

the twin-twisting of two steel bars into one stranded unit. This process of cold deformation raises the yield strength of the ordinary mild steel by 50 per cent. The building regulations of almost all Western countries, therefore, allow a 50 per cent increase in the working stresses for this steel. In other words, two tons of the twin-twisted steel do the work of three tons of ordinary mild steel. A saving of a third of reinforced steel can thus be obtained.

Evolution of Low-cost Equipment

A capital expenditure of approximately Rs. 50,000 is normally required for the plant producing twin-twisted bars. By introducing a radical simplification in this process, the Institute has set up a small pilot plant of simple equipment made in a local workshop at a cost of less than Rs. 2,000. This will make it possible to produce twin-twisted bars at a small capital cost and the process could be used on all major construction jobs with considerable saving of steel.

Pre-stressed Concrete

The principal advantages of pre-stressed concrete as compared with reinforced concrete are: (*i*) saving in steel up to 85 per cent; (*ii*) saving in concrete and, consequently, in cement up to 50 per cent; (*iii*) improved load-carrying capacity; (*iv*) better performance with regard to weather resistance; (*v*) pre-stressed concrete is elastic while reinforced concrete is brittle; and (*vi*) structures in pre-stressed concrete are more slender and elegant. A few pre-stressed concrete structures have already been erected in India. A pilot plant is being established to produce a wide variety of products from pre-stressed concrete.

12. Central Salt Research Institute, Bhavnagar

The Salt Research Committee of the Council of Scientific and Industrial Research received a proposal from the Government of India for the establishment of a National

Laboratory for carrying out research on salt and for dealing with problems concerning marine salt, salt from salt lakes and sub-soil brine and mine salt. Accordingly, the Central Salt Research Institute was established at Bhavnagar in Saurashtra in April 1954.

Functions

The main functions of the Institute are to improve the quality of sea and lake brine salt and to investigate the recovery and utilization of by-products.

Progress of Work

Work is, at present, concentrated on the production of table salt of standard quality and on the separation of salts present in Sambhar Lake bitterns. The work relating to the production of mixed nitrogen-potash fertilizer by ammoniation-carbonation of sea bitterns, which was initiated in the National Chemical Laboratory, is being continued in the Institute. Light basic magnesium carbonate is obtained as a by-product. The chemical engineering and economic aspects of production are under investigation.

Table Salt from Crude Marine Salt

The optimum conditions for making table salt from crude marine salt have been determined and a simple process for obtaining a product consisting of nearly round crystals ranging in mesh size between 18 and 72 British Standard Sieve and analysing to 99.8 per cent sodium chloride has been worked out.

Mixed Nitrogen-Potash Fertilizer

India produces annually two million tons of salt by fractional solar evaporation of sea-water and some other brines. The bitterns left over contain 429,000 tons of magnesium chloride, 285,000 tons of magnesium sulphate and 83,000 tons of potassium chloride. These bitterns have been used as a fixing agent for ammonia in the same way as gypsum is used for the manufacture of ammonium sulphate, thus providing a raw material for increased

production of nitrogenous fertilizers. The fertilizer so obtained retains all the potash present in sea-water. The method consists in simultaneous ammoniation and carbonation of the bitterns followed by filtration of the precipitated magnesium carbonate. On evaporation of the filtrate, a product containing N 18.5 per cent and K_2 O 4.6 per cent is obtained.

Light Magnesium Carbonate

Light magnesium carbonate (bulk density 130 g./litre) has been prepared by the ammoniation-carbonation of sea bitterns. It has good qualities as a filler.

Extra light magnesium carbonate (bulk density c.45 grams/litre) has been obtained by the treatment of Sambhar bitterns (which contain sodium carbonate) with magnesium chloride. The initial treatment for the removal of sodium carbonate, followed by the processing of the sodium chloride-sodium sulphate-water system, provides a process which may revolutionize the Sambhar salt industry.

13. National Botanic Gardens, Lucknow

In May 1953, the Council of Scientific and Industrial Research took charge of the Sikander Bagh, Lucknow, from the U.P. Government with a view to developing it as a national botanic garden. It was considered that a botanic garden with a well-equipped herbarium would help in the development of drug research at the Central Drug Research Institute in Lucknow.

Scope and Functions

The scope and functions of the National Botanic Gardens include: (1) botanical research including plant breeding, developing new plant varieties of economic importance and horticultural research; (2) research on cultivation of medicinal, fibre-yielding and essential oil-bearing plants; (3) maintenance of a national herbarium and an

arboretum; and (4) training of botanists and horticulturists.

The Garden

The garden is being relaid on modern lines. Green houses and artificial lakes are under construction and a rosarium is being organized.

Graft varieties of mango, guava, amla and gutties of different varieties of citrus have been raised. Several varieties of bananas and pine-apples have also been introduced, besides raising seedlings of vegetable plants from improved seeds. A separate botanical section is maintained for the display of the representative plants of different families to students of educational institutions.

The Herbarium

A nucleus of a herbarium has been organized with specimens representing all plant groups. Of these, the largest in number are flowering plants obtained from abroad. Already, nearly 5,000 specimens have been identified and systematically lodged. As a result of a survey of north-western Himalayas in Kashmir, a large number of plants have been collected for the herbarium and the garden. A district-wise botanical survey has been started in Uttar Pradesh. A systematic catalogue of the material in the herbarium is also under preparation.

The Horticulture Laboratory

A horticulture laboratory has been organized and the following problems are under investigation: (1) application of hormones in horticulture with particular reference to rootage and prevention of pre-harvest fruit drop; (2) studies on nutritional requirements of fruit trees; (3) growth, flowering and fruiting behaviour of fruit trees; (4) improvement of some major fruit plants of U.P.; (5) vernalization and photo-periodic induction in some horticultural crops; and (6) morphological and cytogenetical studies in the family *Cucurbitaceae*. A large variety of melons have been collected and sown in the village of

Mirzapur, 5 miles from Lucknow, under ordinary village conditions.

Medicinal Plants

Over 500 species of medicinal plants are being grown in nursery plots. *Plantago ovata, Althaea rosea, Cichorium intybus, Calendula* and *Piper longum* have been cultivated on a large scale. A method of quick multiplication of the drug plant *Rauwolfia serpentina* has also been developed.

14. Central Electronics Engineering Research Institute, Pilani

Electronic devices today play an increasingly important part in science and industry. In India, research in radio and electronics was originally confined to a few centres like the Calcutta University Institute of Electronics, the National Physical Laboratory, the Tata Institute of Fundamental Research in Bombay and the Indian Institute of Science in Bangalore. These centres were, however, not able to meet all our needs.

The Central Electronics Engineering Research Institute was established at Pilani to fill the lacuna in one of the basic fields of modern scientific research in the country. The foundation-stone of the Institute was laid on September 21, 1953.

Scope and Functions

The object of the Institute is to undertake research and development on all aspects of electronic engineering. Special attention is devoted to the utilization of indigenous raw materials for the manufacture of components, the development and use of electronic circuits for industry, the building of standard electronic instruments for conducting tests, investigations on radar and other types of equipment and the application of electronics to industrial purposes. The Institute also undertakes projects sponsored by industry.

15. Central Mining Research Station, Dhanbad

Problems relating to safety in mines and the improvement of conditions and efficiency in the mining industry in general have long exercised the minds of Indian mining engineers. The Coal Mining Committee of 1937 and the Indian Coalfields Committees of 1937 and 1946 had recommended the setting up of a Coal Research Board to initiate and direct research in coal utilization and mining problems. Accordingly, the Council of Scientific and Industrial Research decided, in 1954, to establish a Mining Research Station at Dhanbad.

Scope and Functions

The station is concerned with investigations directed to the improvement of safety, health and efficiency in mines. The subjects of research at the institute are: mine gases, mine ventilation and lighting; blasting and explosives; spontaneous combustion, mine fires, explosions of fire damp and coal dust; problems of accidents arising from haulage and winding; subsidence, strata movements and roof supports; hygiene, mine dusts and mine diseases; testing and certifying mine equipment and the designing and development of special apparatus of benefit to the mining industry.

The station has carried out research work on mine air analysis and testing, and initiated studies on mine ventilation and mine explosions. As a first step, it has undertaken a survey of mine ventilation conditions in the mines of Bihar and Bengal in collaboration with the Mines Inspectorate.

Technical Aid

The station has rendered technical aid to the Department of Mines and private collieries by way of assistance and advice on sampling and analysis of mine gases, mine combustion and diesel engine exhausts in the mines.

16. Indian Institute for Biochemistry and Experimental Medicine, Calcutta

The Indian Institute for Medical Research was started in 1935 by a group of scientific workers in Calcutta to promote organized research in the country. The Institute was taken over by the Council of Scientific and Industrial Research in April 1956 and renamed the Indian Institute for Biochemistry and Experimental Medicine. It is concerned mainly with fundamental experimental studies in biochemistry and medicine.

Biochemical and Nutritional Research

A large number of common Indian foodstuffs have been examined at the Institute, especially with reference to their protein, vitamin and mineral content. Vitamin A values of fish liver oils and Vitamin C content of Indian fruits like mango, *lichi*, guava, etc., have been investigated and nutritional surveys of typical Bengali diets carried out.

Leishmaniasis

Research on the cultivation of Leishmania parasites on solid media, serology and antigenic structure of various Leishmania parasites, besides the treatment of oriental sore and post kala-azar dermal leishmaniasis with Leishmania vaccines, have been carried out. These constitute the first successful introduction of protozoal vaccines into therapy. The Institute has developed a new test for the diagnosis of kala-azar, using the complement-fixation test with antigen prepared from flagellated cultures of *leishmania donovani* on Ray's medium.

Amoebiasis

Extensive studies on the physiological activities of Entamoeba histolytica and metabolic characteristics of the ameoba have been carried out with a view to growing *E. histolytica* in a bacteria-free medium. A complement-fixation test has been developed for the diagnosis of amoebiasis.

Other Research

The mechanism of bacterial allergy in tuberculosis has been studied through the characterization of urinary proteose. Its antigenic specificity akin to tuberculin has opened up a new line of approach towards the understanding of endogenous allergy.

At the same time, the treatment of drug and food allergies through specific deallergization by propeptans has been attempted. Finally, the isolation, activity, mode of action and chemical properties of phytoncides and their invitro bactericidal and protistocidal actions have been studied.

Aid to Industry

The Institute has also undertaken a few research projects which are of interest to industry. These include the production of biological products, such as tuberculin toxoids, pertussis vaccine, Rh-antisera, small-pox sera, antigens for complement-fixation tests, allergens and other biological materials for diagnostic and therapeutic measures, gammaglobulins, fibrin, fibrionogen, etc., antigens for imparting immunity against multiple communicable diseases, diastatic and proteolytic enzymes, newer types of penicillin and ascorbic acid from glucose chorionic gonadotrophin hormone.

17. Regional Research Laboratory, Hyderabad

The Central Laboratories for Scientific and Industrial Research, Hyderabad, were taken over by the Council of Scientific and Industrial Research on April 1, 1956, and constituted as a Regional Research Laboratory.

Scope and Functions

The Laboratory aims at helping the Government and industry through research on projects formulated on the basis of regional needs and resources. In its selection of

problems and the carrying out of investigations, the Laboratory ensures that the results of research are utilized by industry. Research within the sections is co-ordinated by an Operational Research Unit with a view to bringing about maximum concentration of effort.

RESEARCH PROJECTS

With Hyderabad producing 14 lakh tons of coal annually, its efficient utilization is a problem of major concern to the Laboratory. The coal extracted is of the high-ash, high-volatile, non-coking class. Low-temperature carbonization of the coal in a 25-ton per day plant installed in the Laboratory at a cost of Rs. 7 lakhs has given valuable technical data. The coke obtained, which is marketed locally under the trade name 'Coalsite', has proved popular as a domestic fuel.

Non-coking Coal Fines

Processes have been developed for briquetting coal fines without binders and using high pressures ranging from 10 to 23 tons per square inch. Low temperature tar, after suitable modification with lime, has proved to be an excellent binder for low pressure briquetting.

Cotton Seed Utilization

Cotton seed, a major produce of Hyderabad, forms a good source of high class cooking and edible oil. Most of the seed is, at present, used as cattle feed. For its better utilization, complete units for delinting and dehulling have been erected and an efficient oil expeller has been installed. These units are intended to furnish technical data on the processing of various types of cotton seeds.

Dehydrated Castor Oil

A process for the production of low viscosity, dehydrated castor oil has been developed which finds extensive use in the paints and varnish industry. Other valuable products like triricinolein, which is stated to be an almost indispensable lubricant for jet engines and a bactericidal agent for tooth-pastes, have been designed.

Hand-made Paper

A study has been made on a pilot plant scale of the processes involved in the manufacture of hand-made paper. The plant produces daily 1½ tons of paper of excellent quality and different grades—writing, drawing, bond, ledger, cover and card. The paper compares favourably with foreign hand-made paper, large quantities of which are being imported. Based on the experience gained, an improved paper-lifting vat, called the 'Centre Vat', has been designed and installed in the Laboratory.

Chemicals from Molasses

The Laboratory has developed processes for the utilization of molasses as a raw material for the preparation of several chemicals, *e.g.*, levulinic acid, citric acid and itaconic acid. A process has also been worked out for the production of calcium gluconate from glucose and glucose syrup by microbiological methods.

Active Carbons

High quality active carbons have been prepared from groundnut hulls and teakwood sawdust by a process involving mineral salt treatment and carbonization. Active carbons suitable for refining vegetable oils and sugar have also been developed.

Future Programme

Systematic work on Hyderabad clays has been initiated with a view to providing data for the expanding glass and ceramic industry. Work on processes for the production of various inorganic chemicals, *e.g.*, iron-free alum and potassium salts from felspar, sulphur from sulphur dioxide and hydrogen sulphide, manganous sulphate from pyrites, aluminium from bauxite and production of phosphatic and nitrogenous fertilizers, is in progress. Other problems taken up by the Institute include detergents from castor oil, insecticides from Indian turpentine oil, development of palmarosa and gingergrass oils and microbiological production of calcium gluconate.

Besides the 17 laboratories mentioned above, eight other laboratories are functioning under the control of the Council of Scientific and Industrial Research. These are (*i*) Birla Industrial and Technological Museum, Calcutta; (*ii*) Regional Research Laboratory, Jammu-Tawi; (*iii*) Central Mechanical Engineering Research Institute, Durgapur; (*iv*) Central Public Health Engineering Research Institute, Nagpur; (*v*) National Aeronautical Laboratory, Bangalore; (*vi*) Regional Research Laboratory, Jorhat-Assam; (*vii*) Central Indian Medicinal Plant Organization, New Delhi; and (*viii*) Central Scientific Instruments Organization, New Delhi. While the Birla Engineering and Technological Museum depicts the country's scientific and technological progress, the Regional Research Laboratory in Jammu carries out research in problems directed to medicinal plants in the Kashmir region of the Himalayas. The Central Mechanical Engineering Research Institute conducts research in mechanical engineering in all its aspects. The Central Public Health Engineering Research Institute takes up research in all aspects of public health engineering and co-ordinates the work of all agencies interested in this field in the country. The National Aeronautical Laboratory undertakes scientific investigation of the problems of flying with a view to their practical application to the design, construction and operation of aircraft in India. The Regional Research Laboratory at Jorhat undertakes research on problems relating to more efficient utilization and better conservation of important national resources of Assam and other regional needs posing special problems. The Central Indian Medicinal Plant Organization co-ordinates activities for the development of cultivation and utilization of medicinal plants on organized basis. The Central Scientific Instruments Organization's function is the promotion and development of indigenous manufacture of scientific instruments for teaching, research and industry.

Sponsored Research

In addition to running the 25 national laboratories, the Council of Scientific and Industrial Research also sponsors research in other research institutions. Through a system of liberal grants-in-aid, scientists in other research laboratories and universities are enabled to pursue fundamental and applied research in their special fields. There are, at present, 390 such schemes in progress in over 82 research centres in the country. Apart from the practical results achieved, the schemes provide opportunities of training for young research workers and help the development of active centres of independent research work.

III. CONCLUSION

India's economy is underdeveloped. Since Independence the country is making great efforts to develop it by giving it a wide industrial base. Industrial research assumes a key role in this context. The research laboratories set up by the Council of Scientific and Industrial Research are important milestones on the road to industrial development. Each laboratory that is set up helps in the process of India's industrialization and economic regeneration. With the establishment of these laboratories, scientific research in the country may be said to have come into its own.

APPENDIX

NATIONAL LABORATORIES / INSTITUTES

Sl. No.	Name of Laboratory	Location
1.	National Chemical Laboratory	Poona
2.	National Physical Laboratory	New Delhi
3.	Central Fuel Research Institute	Jealgora (Bihar)
4.	Central Glass and Ceramic Research Institute ..	Jadavpur
5.	Central Food Technological Research Institute..	Mysore
6.	National Metallurgical Laboratory	Jamshedpur
7.	Central Drug Research Institute	Lucknow
8.	Central Road Research Institute	New Delhi
9.	Central Electro-Chemical Research Institute ..	Karaikudi (Madras)
10.	Central Leather Research Institute	Madras
11.	Central Building Research Institute	Roorkee
12.	Central Electronics Engineering Institute ..	Pilani (Rajasthan)
13.	National Botanic Gardens	Lucknow
14.	Central Salt Research Institute	Bhavnagar
15.	Central Mining Research Station	Dhanbad
16.	Regional Research Laboratory	Hyderabad
17.	Indian Institute for Biochemistry & Experimental Medicine	Calcutta
18.	Birla Industrial & Technological Museum ..	Calcutta
19.	Regional Research Laboratory	Jammu-Tawi
20.	Central Mechanical Engineering Research Institute	Durgapur (W. Bengal)
21.	Central Public Health Engineering Research Institute	Nagpur
22.	National Aeronautical Laboratory	Bangalore
23.	Regional Research Laboratory	Jorhat (Assam)
24.	Central Indian Medicinal Plant Organization	New Delhi
25.	Central Scientific Instruments Organization ..	New Delhi

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